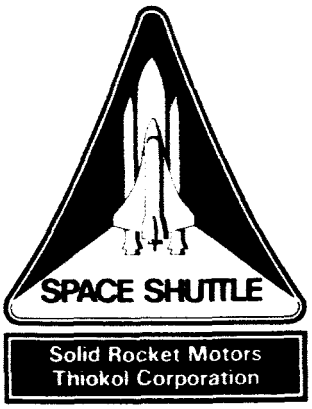
TWR-19978




# RSRM Forward Dome Inhibitor Void/Thin Insulation Process Validation Final Test Report



Prepared for

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Contract No. NAS8-30490
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*Publications No. 90335*

# RSRM Forward Dome Inhibitor Void/Thin Insulation Process Change Validation

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## ABSTRACT

Qualification testing of the improved RSRM forward dome insulation layup process was conducted at Thiokol Corporation's M-111 Manufacturing Facility and was completed on 4 Dec 1989. The purpose of the test was to validate this new insulation process and to show that the process is compliant with the approved engineering drawings. This process change will result in improved insulation material flow during cure and reduce the occurrence of interply and insulation to case wall voids and thin insulation.

All test objectives were successfully accomplished. The cured insulation was inspected using radiographic, ultrasonic, and visual methods and was free of any anomalous conditions. Inspection also confirmed that the insulation conformed to all engineering requirements and would be acceptable for use in the RSRM production motor.

As a result of the successful completion of all testing and the satisfaction of all test objectives, it is recommended that this insulation process change be approved for use on RSRM flight motors.

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## FIGURES



## TABLES



## ATTACHMENTS

1

# INTRODUCTION

This report documents the procedures, performance, and results obtained from tests that were performed per Test Plan CTP-0161--RSRM Forward Dome Inhibitor Void/Thin Insulation Process Change Validation. The purpose of this testing was to validate changes to the insulation layup process in the forward dome inhibitor region. The intent of this change is to eliminate interply and insulation to case wall voids, irregularities in insulation flow during cure, and thin insulation in this area. The test was performed from 7 Nov to 4 Dec 1989 at Thiokol Corporation's Space Manufacturing Facility.

## 1.1 TEST ARTICLE DESCRIPTION

The test article consisted of a full-scale RSRM forward segment (forward dome and barrel section) which was controlled by Engineering Drawing No. 7U77105--Forward Dome Process Verification Test Article. Up to the Chemlok® operations, this segment was processed according to normal RSRM segment manufacturing planning. The only differences between this test article and a typical RSRM segment were:

a. The barrel section was painted inside and outside to prevent corrosion of the cylinders during testing.

b. Only the forward dome itself had Chemlok® applied to it inasmuch as this was the area of evaluation for the test.

c. Grit blasting that would normally occur at the H-7 Clearfield facility, was performed in M-52 in order to expedite testing.

d. Hardware used in this test was designated nonflight having been disapproved for flight use. However, in the areas of interest for this testing, there were no differences between the test article and actual flight hardware.

A full-scale test article was necessary for this test in order to properly simulate and duplicate normal RSRM segment processing. Standard manufacturing planning (CPI RA33X) and all equipment, shop aids, tooling, and material inherent to that planning were used to build the test article. However, a new manufacturing drawing, No. 5U77105--Forward Igniter Boot Process Chamber Layup, was generated and used to implement the new insulation layup in the dome. Specific details of the insulation layup are discussed in Section 6.

## OBJECTIVES

The objectives of Test Plan CTP-0161 are detailed below. CEI Specification requirement paragraphs are listed in parentheses.

a. Validate that metal case is not degraded by heat (3.2.1.8.1.1.a).

b. Validate that the insulation complies with performance requirements under worst-case manufacturing tolerances during assembly and operation (3.2.1.8.1.1.e).

c. Validate that a minimum structural safety factor of 2.0 is maintained (3.3.6.1.1.2).

d. Validate that the insulation is designed in accordance with TWR-16742 using the data base provided in TWR-16278 (3.3.6.1.2.1).

e. Calculate the safety factor using actual pre/postfire motor insulation thickness measurements. This will determine insulation loss and minimum drawing thickness (3.3.6.1.2.6).

f. Validate that insulation is free of hazardous defects and defects that could reduce part reusability (workmanship) (3.3.13).

g. Evaluate the defect detection inspection system.

# 3

# EXECUTIVE SUMMARY

## 3.1 SUMMARY

This section contains an executive summary of the key results from test data evaluation and post-test inspection. Additional information and details can be found in Section 6, Results and Discussion.

All tests were successfully completed and all objectives were satisfied. Postcure evaluation of the forward dome insulation revealed no anomalies of any kind. Furthermore, the cured insulation was well within all engineering requirements, had uniform material thickness, showed improved vulcanization between material plies and sections, and had a smooth surface finish which enhances pin gage and ultrasonic inspection capabilities.

## 3.2 CONCLUSIONS

The following are the conclusions as they relate specifically to the objectives. Additional information about the conclusions can be found in Section 6, Results and Discussion.

| | Objective | Results |
|---|---|---|
| a. | Validate that the metal case is not degraded by heat. | * |
| b. | Validate that the insulation complies with performance requirements under worst-case manufacturing tolerances during assembly and operations. | * |
| c. | Validate that a minimum structural safety factor of 2.0 is maintained. | * |
| d. | Validate that the insulation is designed in accordance with TWR-16742 using the data base provided in TWR-16278. | * |
| e. | Validate that the insulation erosion Safety Factor is 1.5 minimum. | * |

| | Objective | Results |
|---|---|---|
| f. | Calculate the safety factor using actual pre/postfire insulation thickness measurement. This will determine insulation loss and minimum drawing thickness. | * |
| g. | Validate that the insulation is free of hazardous defects and defects that could reduce part reusability. | Post-test radiographic, ultrasonic, and visual inspection confirmed that the test article was free of any defects (voids and folds). These inspections also confirmed that the insulation thickness, inhibitor-to-dome radius, and all other dimensions were within specified engineering requirements, and complied with Drawing No. 1U76666. |
| h. | Evaluate the defect detection inspection system. | This test objective is associated with ETP-0534, a feasibility study on ultrasonic inspection techniques. It was included as part of this testing due to test article availability. Results and conclusions regarding this test objective will be reported in TWR-50311. |

*The test article was assembled in compliance with the design requirements of Drawing No. 1U76666--Case Assembly, Forward Segment Insulated. All assembly and inspection requirements of Drawing No. 1U76666 were met or exceeded. Therefore, the test article complied to the CEI specifications related to Objectives A through G, and the objectives were met.

## 3.3 RECOMMENDATIONS

As a result of the assembly and inspection compliance with Drawing No. 1U76666, it is recommended that this process change be approved for use on RSRM flight motors.

## 4

## INSTRUMENTATION

Standard laboratory equipment calibrations traceable to the National Institute of Standards and Technology (NIST) were used to support this test. Also, all calibrated measuring and test equipment used in this test program was in compliance with MIL-STD-45662.

## 5

## PHOTOGRAPHY

Still photographs were taken during various stages of the test program. Figures 1, 2, and 3 are included in this report for information. Copies of the additional photographs (Series No. 114589, No. 114355, and No. 114545) are available from Thiokol Photographic Services department.

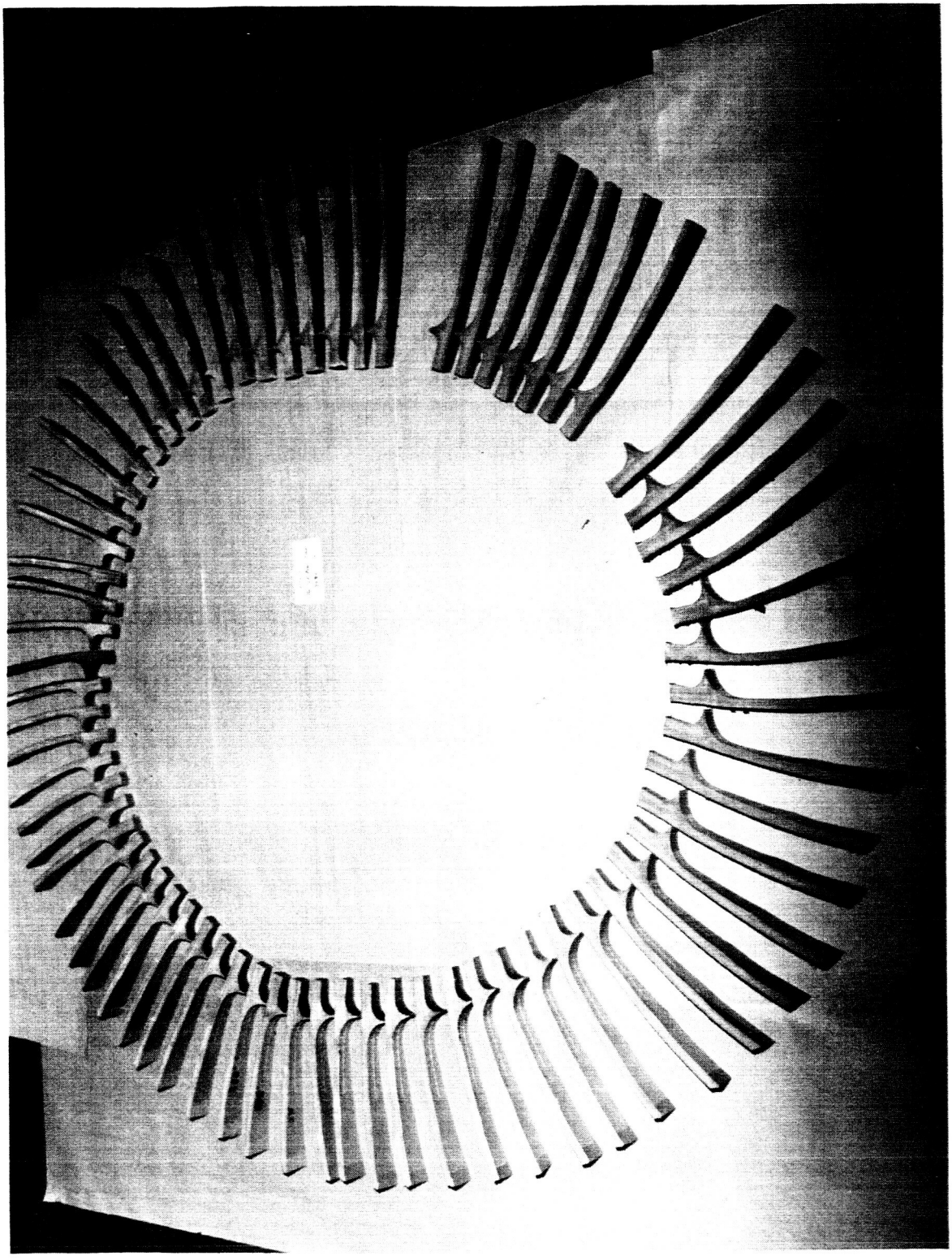

Figure 1. Dissected Insulation

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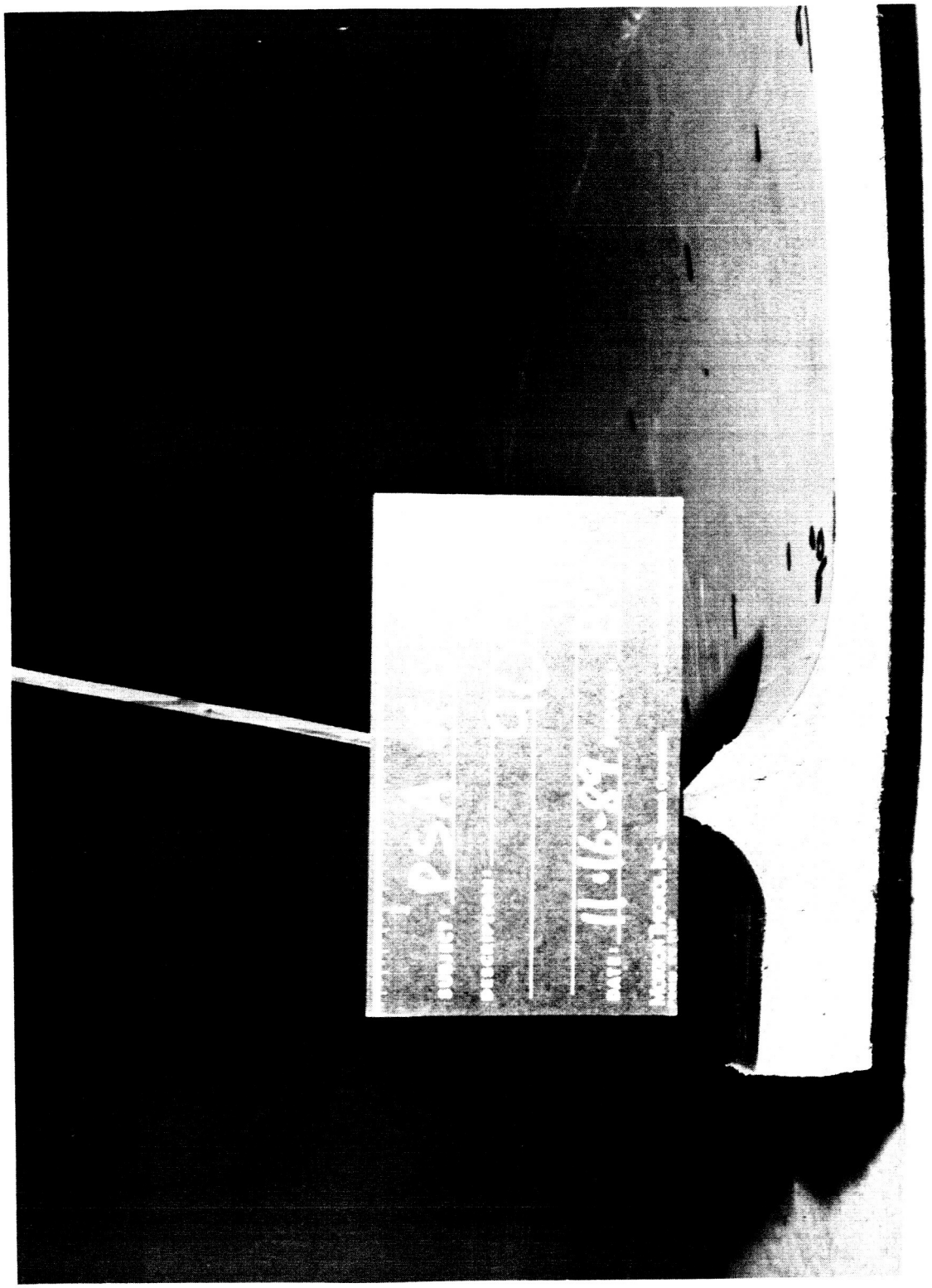

Figure 2. Dissected Insulation

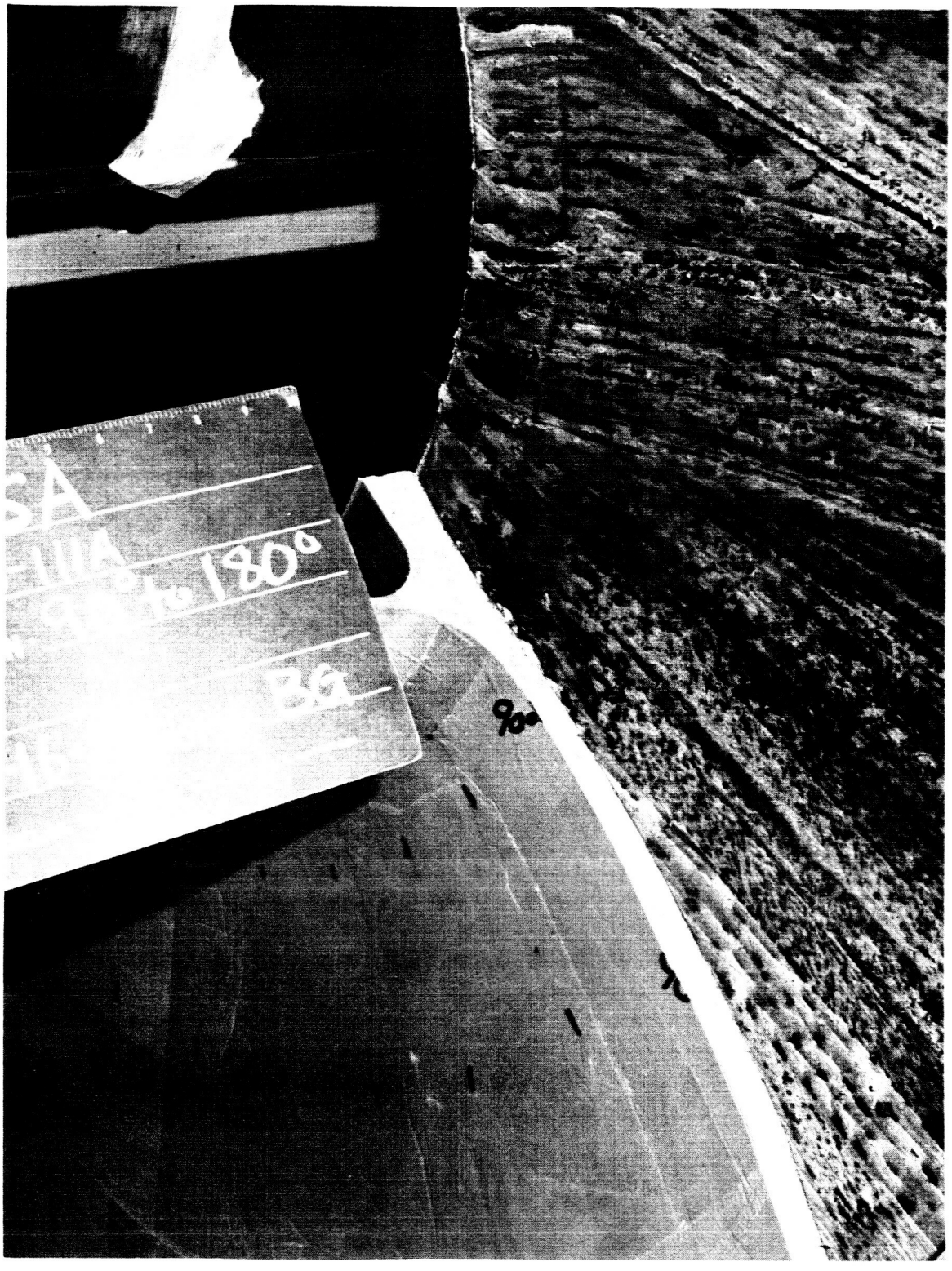


Figure 3. Dissected Insulation

# 6

# RESULTS AND DISCUSSION

## 6.1 ASSEMBLY

The hardware used in this study was nonflight hardware using standard tooling. The forward dome used in this study had been used on the previous Process Simulation Article (PSA) studies. All operations were performed by production operators.

The forward dome surface preparation (including Chemlok® 205 and 233 application) performed for this study was typical to a production forward dome flow except the inside diameter (ID) surface grit blasting was conducted at M-52 instead of H-7. After the Chemlok® 233 was applied, the dome was assembled to the barrel section to create a forward segment and then moved to the M-111 Annex for insulation layup.

During the performance of this test program, the test article was re-identified from PSA-6 to PSA-5. Throughout the remainder of this report any reference to PSA-6 should be understood to mean PSA-5.

## 6.2 TEST

Rubber layup was accomplished in the standard horizontal position using the layup platform. Rubber layup was per Layup Sketch No. 5U77105-101. The changes in layup incorporated into this configuration are shown in Figure 4 and detailed as follows. The previous configuration is shown in parentheses.

a. Molded region plies--One piece circle pattern (3- piece pattern)
b. Three base patterns--Match skive all joints (overlap/skive joints)
c. Base ply under -301, -401 mold ring - 0.200-in. thick (previously 0.130-in. thick)

Changes unique to this test configuration were:

d. Removal of 0.100-in. pattern from under the -301, -401, mold rings.
e. Additional 0.050-in. ply to represent change of thin insulation ECP (SRM-2146R1) requirement.
f. 0.100-in. layer applied over outside diameter (OD) radius extrusion
g. The pressure transfer ring used to prevent vacuum bag/cloth bridging in the inhibitor radius was deleted.

A 3-piece CAD/CAM design vacuum bag cloth breather system was used (Figure 5) in the forward dome inhibitor area and was extended onto the dome. The Chickopee strips extending

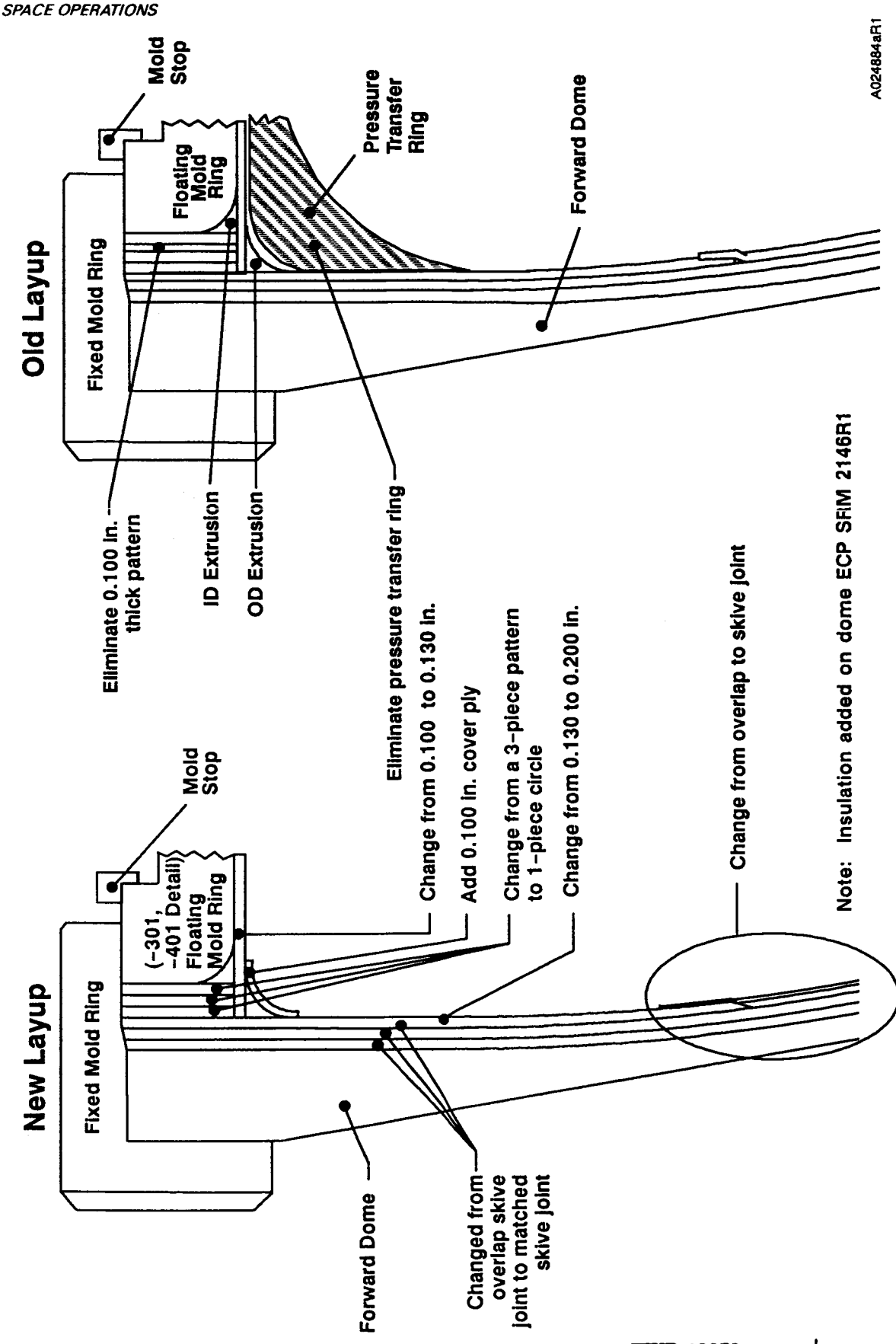


Figure 4. Forward Dome Insulation Layup Changes

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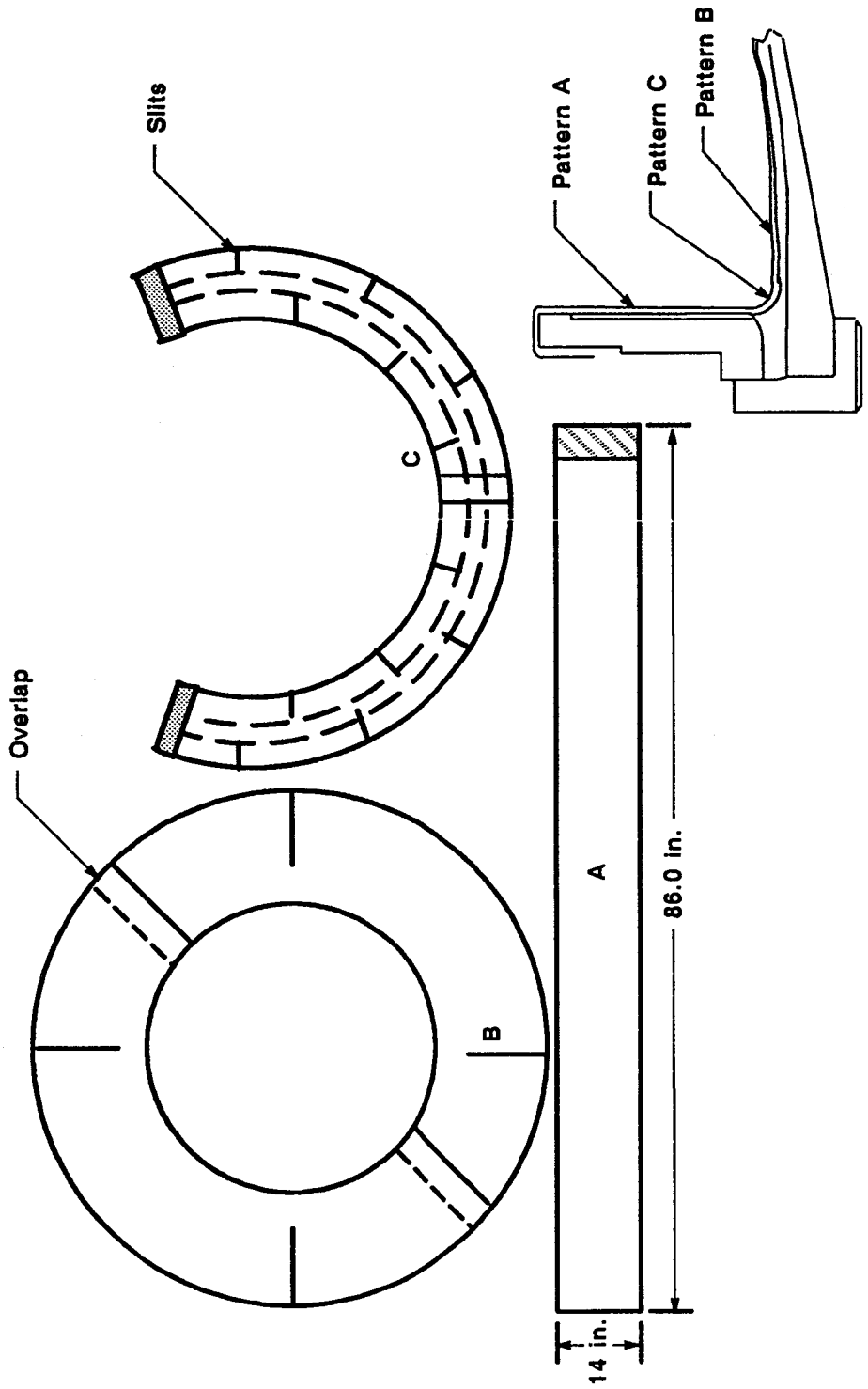


Figure 5. Three-Piece Patterning/Breather Cloth Patterns

forward up the dome were split into 1- to 1.5-in. strips where they intersected the inhibitor radius. Another Chickopee pattern was wrapped circumferentially around the inhibitor and extended aft over the vacuum manifold in the inhibitor mold and forward to overlap the Chickopee cloth strips.

The vacuum bag extended aft of the layup (outboard dome region) and forward through the dome and was sealed to the outside of the dome. Vacuum was pulled through the igniter mold ring only. The assembly was then cured using an autoclave cure cycle was based on the average cure cycle from five production forward segments (Figure 6).

## 6.3 RESULTS

Postcure visual inspection determined the inhibitor radius to be well formed and the profile very uniform. Pin gage (contour gage) measurements were taken of the inhibitor-to-dome radius at ten predesignated locations 24, 77, 103, 143, 164, 210, 248, 276, 296, and 342 deg. All profiles were within the drawing radius requirements and showed consistent side-by-side comparisons. The pin gage profile taken at 24 deg is shown in Figure 7. This profile is typical of the remaining pin gage profiles. The remainder of the pin gage profiles are available at Space Operations Configuration Management and Records.

The 90 to 180 deg section (extending approximately 18 in. into the dome) was removed and dissected into 5 deg increments to provide a quick detail defect (void) visual analysis. No anomalies of any kind were observed (Attachment 1). The test dome, containing the remaining 270 deg of insulation, was X-rayed. No defects were detected (Attachment 2). Ultrasonic thickness inspection was conducted at ten predetermined degree locations. All thicknesses were well within tolerances and consistent around the circumference (Table 1). Random ultrasonic inspection was also conducted to scan for thin areas. All measurements were well above minimum required drawing thicknesses. These measurements are provided in Table 1.

The remaining forward dome inhibitor region insulation was carefully removed from the test dome and dissected into 5-deg sections. Visual analysis of the cross sections revealed no anomalies (Attachment 3).

Insulation thickness measurements of the 5-deg sections were taken by the R&D Lab. These measurements (Table 2) show a smooth configuration (average thickness = 0.587, with a standard deviation of ±0.009 in. in the region 5.0 to 8.0 in. from igniter boss). These profile measurements show a minimum local thickness of 0.552 in. (versus 0.503-in. design minimum). An average, maximum, and minimum thickness profile graph; and a circumferential profile graph (shown in Figure 8) demonstrate the excellent control and consistency of the thickness profile of this forward dome inhibitor region.

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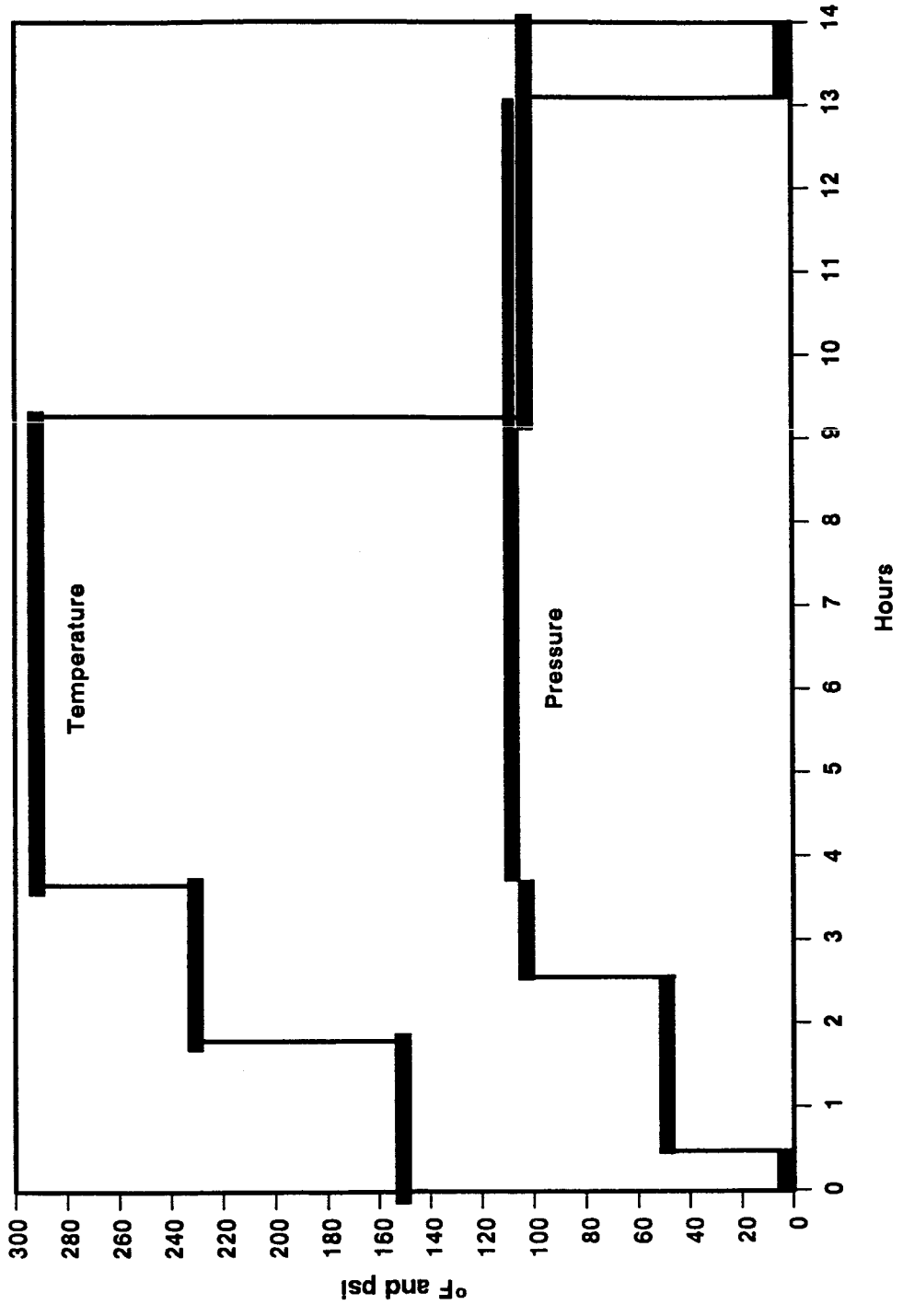



Figure 6. Typical Forward Segment—Insulation Cure Cycle

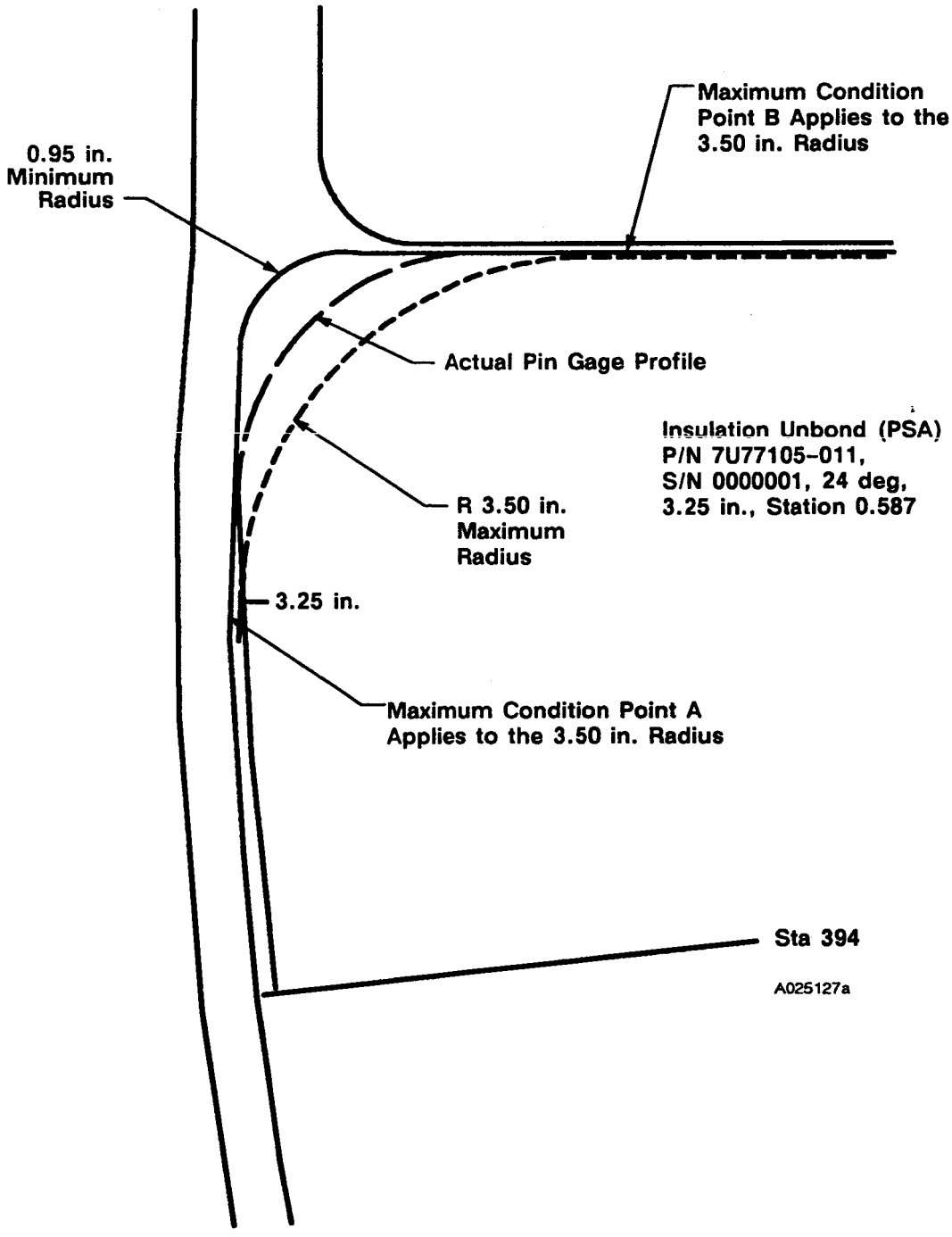
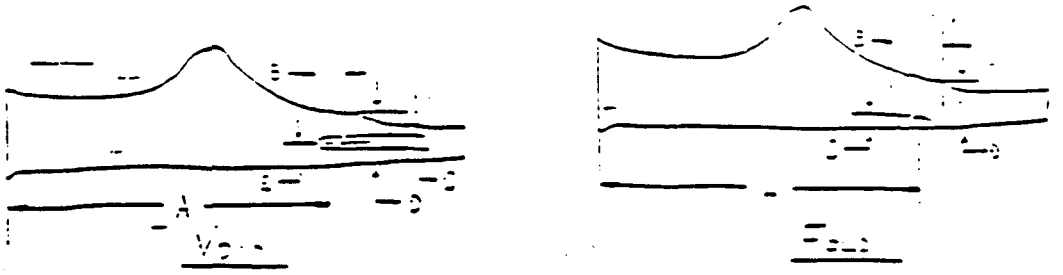



**Figure 7. 24-deg Actual Pin Gage Profile**

## Attachment 1. Defect Location Chart--0 to 90 deg



SEGMENT AREAS: PSA #5 0-90 and/or 180-360 DATE: 11/28/89

| NO. | DEG. LOCATION | A | B | C | D | E | TYPE VOID/FOLD |
|---|---|---|---|---|---|---|---|
| | No Folds or Voids in PSA #5 0-90 and/or 180-360 | | | | | | |

Mack Finlayson
x 6113

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Attachment 2. X-ray Observations

Thiokol CORPORATION
SPACE OPERATIONS

29 November 1989

TO: Sally Foth

FROM: Dennis C. Burt, Space NDE Engineering

SUBJECT: PSA-6 TEST ARTICLE

Tangential X-rays (linear accelerator) and flat shots (isotope iridium 192) on the test article only showed surface indications from 198° through 90°. The area between 90° and 198° was removed prior to X-ray. This area and the edges were not inspected. No obvious missing material indications were found on either set of film.

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## NDT X-RAY REPORT

| SERIAL NO. | PART NAME | PART NO. | DATE | GROUP LEADER/FOREMAN REVIEW | PAGE |
|---|---|---|---|---|---|
| 0000001 | PSA Fwd Segment | 7477105-01 | 22-Nov-89 | | 1 of 1 |

| FILM I.D. | | DISCONTINUITY | | | | | DISCONTINUITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SPECIFICATION NO. Engineering Information only | JOB NO. RA29N 70 0001 | PROJECT NO. 4B501 07 20 | | SIZE | | | | | |
| FILM POSITION (SECTION) | INSP. AREA T-TANGENT B-BODY R-RADIAL | DEG | INDICATION IDENTIFICATION AND DESCRIPTION | | | | FIRST READER'S INITIAL | REVIEW READER'S INITIAL | LENGTH (LONG) | WIDTH (CIR) | DEPTH (RAD) | CLASSIFICATION |
| | R | 0-36 | NO defects detected | | | | KP | SS | | | | |
| | | 54 | 2 Visual Indications - Surface | | | | | | | | | |
| | | 72°-342 | No defects detected | | | | KP | SS | | | | |
| V-43 | IR 192 | 0-90 | Low density on Film Verified to be Visual | | | | TB | TB | | | | |
| | | 198-234 | on the surface of the Insulation | | | | | | | | | |
| | | 252°-342 | NO OTHER DEFECTS DETECTED | | | | KP | SS | | | | |
| V-34 | | 0°-90° | | | | | | | | | | |
| | | 198°-342° | INDICATION ON THE FILM WERE VERIFIED TO BE VISUAL. NO SUBSURFACE DEFECTS DETECTED | | | | DB | TB | | | | |
| V-5 | | 0-90 | NO Defects Detected | | | | TB | TB | | | | |
| | | 198-342 | " " " | | | | | | | | | |

FORM TC 4558 (REV 12-83)

Table 1. PSA-5 Thickness Measurements--NDT Results (ultrasonics)

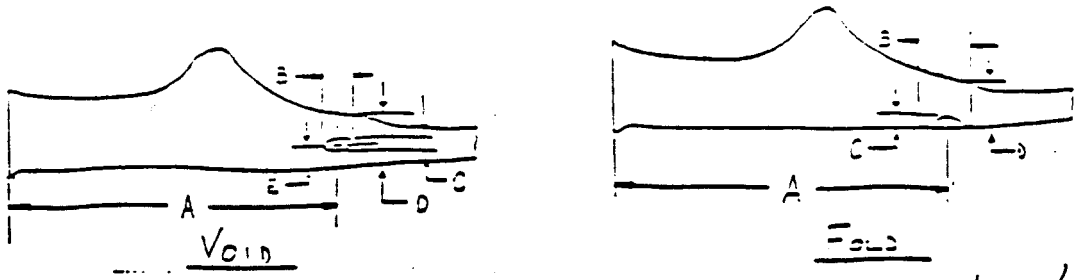
Radial Distance From Igniter Boss

| Degree | 1.5 | 5 | 6 | 7 | 8 | 13 |
|---|---|---|---|---|---|---|
| 74 | 1.111 | 0.609 | 0.609 | 0.613 | 0.615 | 0.610 |
| 90 | 1.100 | 0.607 | 0.604 | 0.610 | 0.608 | 0.608 |
| 140 | 1.150 | 0.620 | 0.602 | 0.618 | 0.621 | 0.606 |
| 154 | 1.131 | 0.602 | 0.618 | 0.611 | 0.617 | 0.618 |
| 206 | 1.120 | 0.606 | 0.609 | 0.613 | 0.618 | 0.621 |
| 222 | 1.117 | 0.621 | 0.614 | 0.616 | 0.604 | 0.619 |
| 270 | 1.127 | 0.614 | 0.610 | 0.624 | 0.622 | 0.621 |
| 286 | 1.133 | 0.611 | 0.603 | 0.611 | 0.625 | 0.610 |
| 336 | 1.136 | 0.611 | 0.608 | 0.632 | 0.626 | 0.622 |
| 352 | 1.127 | 0.608 | 0.617 | 0.614 | 0.617 | 0.620 |
| Average | 1.125 | 0.611 | 0.609 | 0.616 | 0.617 | 0.616 |
| SD | 0.014 | 0.006 | 0.006 | 0.007 | 0.007 | 0.006 |
| Maximum | 1.150 | 0.621 | 0.618 | 0.632 | 0.626 | 0.622 |
| Minimum | 1.100 | 0.602 | 0.602 | 0.610 | 0.604 | 0.606 |

Additional Thickness Results From Scanning Dome

| Degree | Distance From Boss | Thickness |
|---|---|---|
| 24 | 6.250 | 0.587 |
| 77 | 6.750 | 0.605 |
| 103 | 6.500 | 0.579 |
| 143 | 5.750 | 0.586 |
| 164 | 6.000 | 0.591 |
| 211 | 5.750 | 0.587 |
| 248 | 5.750 | 0.582 |
| 276 | 5.750 | 0.591 |
| 296 | 6.250 | 0.581 |
| 342 | 5.750 | 0.589 |

Attachment 3. Defect Location Chart--0 to 90 and 180 to 360 deg




SEGMENT ALIAS: PSA #5 90°-180° DATE: 11/20/89

| NO. | DEG. LOCATION | A | B | C | D | E | TYPE VOID/FOLD |
|---|---|---|---|---|---|---|---|
| | 100° | Section | Missing | | | | |
| | No VOIDS or FOLDS visable | | | | | | |

Mark Tinlayson
6/13

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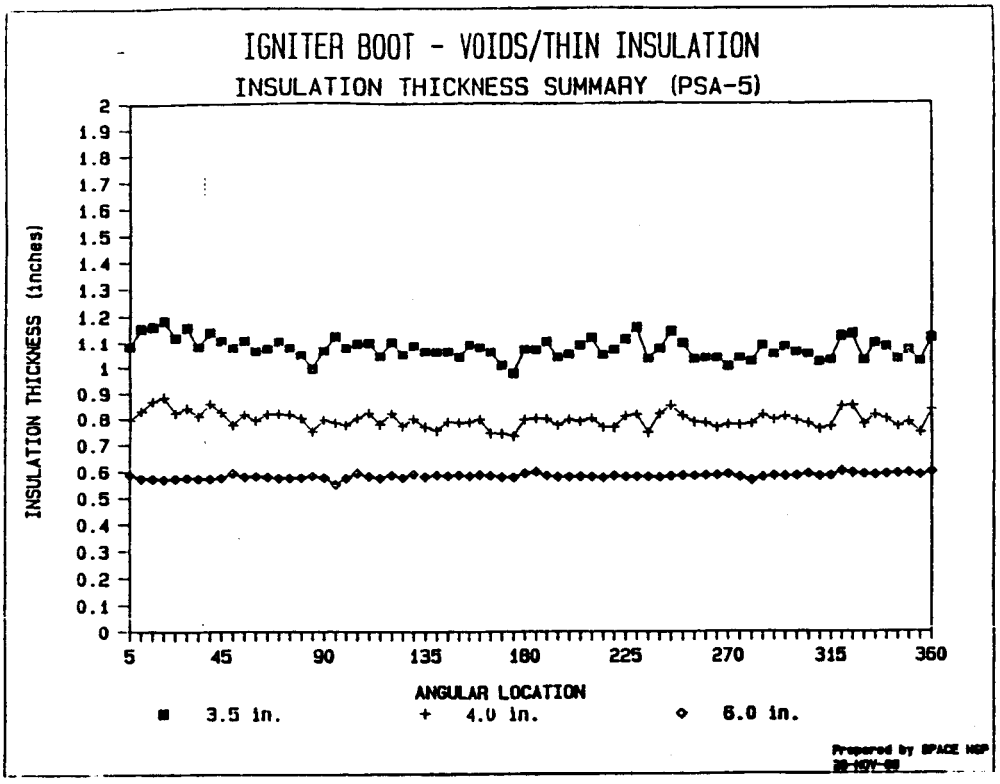
Table 2. PSA-5 Thickness Measurements--Data Summary (28 Nov 1989)

| Angular Location | Radial Distance Outward From the Igniter Boss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 |
| 5 | 1.0830 | 0.7940 | 0.6300 | 0.5850 | 0.5850 | 0.5880 | 0.5940 | 0.5960 | 0.5940 | 0.5970 |
| | 1.1560 | 0.8320 | 0.6760 | 0.6000 | 0.5840 | 0.5750 | 0.5830 | 0.5970 | 0.5950 | 0.5950 |
| | 1.1640 | 0.8700 | 0.6750 | 0.5960 | 0.5770 | 0.5730 | 0.5770 | 0.5930 | 0.5950 | 0.5970 |
| | 1.1870 | 0.8870 | 0.6910 | 0.6040 | 0.5830 | 0.5720 | 0.5740 | 0.5860 | 0.5890 | 0.5890 |
| | 1.1220 | 0.8240 | 0.6570 | 0.5970 | 0.5790 | 0.5740 | 0.5820 | 0.5880 | 0.5950 | 0.5960 |
| | 1.1610 | 0.8440 | 0.6730 | 0.6010 | 0.5760 | 0.5760 | 0.5800 | 0.5930 | 0.5910 | 0.5920 |
| | 1.0860 | 0.8110 | 0.6440 | 0.5930 | 0.5760 | 0.5740 | 0.5780 | 0.5810 | 0.5870 | 0.5870 |
| | 1.1430 | 0.8620 | 0.6610 | 0.5960 | 0.5760 | 0.5740 | 0.5850 | 0.5790 | 0.5820 | 0.5820 |
| 45 | 1.1100 | 0.8280 | 0.6490 | 0.5890 | 0.5800 | 0.5790 | 0.5830 | 0.5860 | 0.5930 | 0.5870 |
| | 1.0810 | 0.7760 | 0.6190 | 0.5760 | 0.5770 | 0.5960 | 0.5920 | 0.5880 | 0.5900 | 0.5870 |
| | 1.1100 | 0.8170 | 0.6390 | 0.5820 | 0.5790 | 0.5810 | 0.5810 | 0.5860 | 0.5940 | 0.5910 |
| | 1.0660 | 0.7920 | 0.6480 | 0.5910 | 0.5800 | 0.5830 | 0.5840 | 0.5850 | 0.5880 | 0.5910 |
| | 1.0760 | 0.8180 | 0.6450 | 0.5920 | 0.5750 | 0.5800 | 0.5880 | 0.5890 | 0.5890 | 0.5910 |
| | 1.1050 | 0.8190 | 0.6550 | 0.5890 | 0.5760 | 0.5750 | 0.5790 | 0.5800 | 0.5870 | 0.5870 |
| | 1.0790 | 0.8160 | 0.6400 | 0.5840 | 0.5700 | 0.5760 | 0.5850 | 0.5860 | 0.5830 | 0.5860 |
| | 1.0490 | 0.8000 | 0.6370 | 0.5850 | 0.5780 | 0.5770 | 0.5850 | 0.5850 | 0.5920 | 0.5840 |
| | 0.9940 | 0.7500 | 0.6140 | 0.5820 | 0.5770 | 0.5840 | 0.5870 | 0.5870 | 0.5950 | 0.5930 |
| 90 | 1.0670 | 0.7950 | 0.6450 | 0.5880 | 0.5780 | 0.5770 | 0.5780 | 0.5800 | 0.5880 | 0.5800 |
| | 1.1240 | 0.7840 | 0.6110 | 0.5600 | 0.5540 | 0.5520 | 0.5530 | 0.5590 | 0.5600 | 0.5640 |
| | 1.0770 | 0.7740 | 0.6280 | 0.5820 | 0.5680 | 0.5760 | 0.5790 | 0.5910 | 0.5870 | 0.5900 |
| | 1.0950 | 0.8020 | 0.6460 | 0.5940 | 0.5850 | 0.5940 | 0.6050 | 0.6110 | 0.6100 | 0.6110 |
| | 1.0980 | 0.8240 | 0.6520 | 0.5910 | 0.5830 | 0.5810 | 0.5910 | 0.5930 | 0.5970 | 0.6000 |
| | 1.0430 | 0.7770 | 0.6280 | 0.5810 | 0.5720 | 0.5740 | 0.5780 | 0.5970 | 0.5940 | 0.6000 |
| | 1.0990 | 0.8210 | 0.6400 | 0.5940 | 0.5840 | 0.5850 | 0.5890 | 0.5940 | 0.5940 | 0.5960 |
| | 1.0500 | 0.7720 | 0.6250 | 0.5780 | 0.5720 | 0.5750 | 0.5830 | 0.5870 | 0.5930 | 0.6000 |
| | 1.0840 | 0.7990 | 0.6270 | 0.5900 | 0.5840 | 0.5900 | 0.6000 | 0.5940 | 0.6050 | 0.6020 |
| 135 | 1.0610 | 0.7670 | 0.6310 | 0.5830 | 0.5720 | 0.5800 | 0.5910 | 0.5750 | 0.5900 | 0.5950 |
| | 1.0600 | 0.7540 | 0.6230 | 0.5820 | 0.5780 | 0.5860 | 0.5950 | 0.5970 | 0.6020 | 0.5990 |
| | 1.0610 | 0.7880 | 0.6180 | 0.5880 | 0.5830 | 0.5830 | 0.5910 | 0.5940 | 0.5980 | 0.6010 |
| | 1.0390 | 0.7830 | 0.6380 | 0.5880 | 0.5820 | 0.5870 | 0.5920 | 0.5980 | 0.5960 | 0.5970 |
| | 1.0890 | 0.7850 | 0.6450 | 0.5980 | 0.5850 | 0.5820 | 0.5880 | 0.5930 | 0.5940 | 0.5950 |
| | 1.0770 | 0.7950 | 0.6250 | 0.5910 | 0.5850 | 0.5870 | 0.5890 | 0.5930 | 0.5960 | 0.5920 |
| | 1.0600 | 0.7420 | 0.6120 | 0.5810 | 0.5800 | 0.5830 | 0.5890 | 0.5990 | 0.5980 | 0.5970 |
| | 1.0070 | 0.7410 | 0.6000 | 0.5700 | 0.5710 | 0.5770 | 0.5820 | 0.5750 | 0.5780 | 0.5790 |
| | 0.9750 | 0.7320 | 0.6180 | 0.5860 | 0.5800 | 0.5760 | 0.5880 | 0.5920 | 0.6000 | 0.6030 |
| 180 | 1.0710 | 0.7960 | 0.6510 | 0.6010 | 0.5870 | 0.5920 | 0.5920 | 0.5940 | 0.5930 | 0.5920 |
| | 1.0710 | 0.8000 | 0.6550 | 0.6020 | 0.5930 | 0.5980 | 0.6030 | 0.6190 | 0.6180 | 0.6160 |
| | 1.1020 | 0.7980 | 0.6380 | 0.5880 | 0.5820 | 0.5820 | 0.5870 | 0.5980 | 0.5910 | 0.5950 |
| | 1.0390 | 0.7730 | 0.6290 | 0.5770 | 0.5720 | 0.5770 | 0.5830 | 0.5910 | 0.5890 | 0.5930 |
| | 1.0530 | 0.7950 | 0.6340 | 0.5830 | 0.5720 | 0.5770 | 0.5810 | 0.5910 | 0.5920 | 0.5930 |
| | 1.0910 | 0.7880 | 0.6360 | 0.5840 | 0.5790 | 0.5790 | 0.5800 | 0.5910 | 0.5940 | 0.5980 |
| | 1.1200 | 0.8000 | 0.6440 | 0.5880 | 0.5750 | 0.5760 | 0.5810 | 0.5900 | 0.5880 | 0.5910 |
| | 1.0520 | 0.7640 | 0.6310 | 0.5860 | 0.5750 | 0.5730 | 0.5830 | 0.5860 | 0.5880 | 0.5890 |
| | 1.0730 | 0.7640 | 0.6250 | 0.5820 | 0.5780 | 0.5810 | 0.5860 | 0.5860 | 0.5860 | 0.5850 |
| 225 | 1.1130 | 0.8090 | 0.6340 | 0.5900 | 0.5760 | 0.5760 | 0.5810 | 0.5840 | 0.5880 | 0.5910 |
| | 1.1560 | 0.8160 | 0.6510 | 0.5850 | 0.5740 | 0.5770 | 0.5810 | 0.5830 | 0.5840 | 0.5850 |
| | 1.0350 | 0.7440 | 0.6130 | 0.5760 | 0.5740 | 0.5770 | 0.5850 | 0.5910 | 0.5900 | 0.5940 |
| | 1.0750 | 0.8180 | 0.6450 | 0.5830 | 0.5700 | 0.5750 | 0.5790 | 0.5890 | 0.5880 | 0.5920 |
| | 1.1400 | 0.8510 | 0.6710 | 0.5950 | 0.5790 | 0.5800 | 0.5810 | 0.5890 | 0.5900 | 0.5920 |

Table 2. PSA-5 Thickness Measurements--Data Summary (28 Nov 1989) (Cont)

| Angular Location | Radial Distance Outward From the Igniter Boss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 |
| | 1.0960 | 0.8090 | 0.6420 | 0.5910 | 0.5810 | 0.5820 | 0.5820 | 0.5930 | 0.5930 | 0.5930 |
| | 1.0300 | 0.7840 | 0.6270 | 0.5860 | 0.5810 | 0.5800 | 0.5860 | 0.5920 | 0.5920 | 0.5890 |
| | 1.0360 | 0.7810 | 0.6200 | 0.5790 | 0.5770 | 0.5810 | 0.5820 | 0.5880 | 0.5880 | 0.5870 |
| | 1.0360 | 0.7620 | 0.6230 | 0.5860 | 0.5770 | 0.5820 | 0.5850 | 0.5890 | 0.5920 | 0.5910 |
| 270 | 1.0020 | 0.7750 | 0.6310 | 0.5920 | 0.5830 | 0.5860 | 0.5870 | 0.5940 | 0.5970 | 0.5920 |
| | 1.0370 | 0.7720 | 0.6220 | 0.5770 | 0.5720 | 0.5740 | 0.5760 | 0.5890 | 0.5910 | 0.5910 |
| | 1.0230 | 0.7770 | 0.6290 | 0.5620 | 0.5560 | 0.5620 | 0.5620 | 0.5670 | 0.5720 | 0.5730 |
| | 1.0880 | 0.8110 | 0.6320 | 0.5770 | 0.5730 | 0.5740 | 0.5850 | 0.5860 | 0.5940 | 0.6000 |
| | 1.0530 | 0.7920 | 0.6530 | 0.5820 | 0.5730 | 0.5800 | 0.5890 | 0.5920 | 0.5940 | 0.6000 |
| | 1.0830 | 0.8060 | 0.6370 | 0.5830 | 0.5730 | 0.5770 | 0.5830 | 0.5900 | 0.5920 | 0.5920 |
| | 1.0610 | 0.7900 | 0.6350 | 0.5790 | 0.5750 | 0.5800 | 0.5910 | 0.5890 | 0.5900 | 0.5880 |
| | 1.0520 | 0.7770 | 0.6330 | 0.5850 | 0.5800 | 0.5870 | 0.5900 | 0.5910 | 0.5900 | 0.5930 |
| | 1.0200 | 0.7560 | 0.6050 | 0.5710 | 0.5710 | 0.5780 | 0.5840 | 0.5870 | 0.5880 | 0.5880 |
| 315 | 1.0290 | 0.7660 | 0.6240 | 0.5790 | 0.5740 | 0.5800 | 0.5870 | 0.5950 | 0.5990 | 0.6070 |
| | 1.1240 | 0.8460 | 0.6770 | 0.6070 | 0.5940 | 0.5970 | 0.6060 | 0.6070 | 0.6080 | 0.6090 |
| | 1.1320 | 0.8500 | 0.6610 | 0.6020 | 0.5880 | 0.5890 | 0.5960 | 0.6100 | 0.6110 | 0.6140 |
| | 1.0260 | 0.7740 | 0.6300 | 0.5900 | 0.5820 | 0.5840 | 0.5960 | 0.5970 | 0.6010 | 0.6070 |
| | 1.0950 | 0.8110 | 0.6470 | 0.5940 | 0.5820 | 0.5820 | 0.5900 | 0.5950 | 0.5970 | 0.5990 |
| | 1.0820 | 0.7940 | 0.6410 | 0.5900 | 0.5880 | 0.5850 | 0.5930 | 0.5990 | 0.5990 | 0.6010 |
| | 1.0320 | 0.7640 | 0.6270 | 0.5910 | 0.5880 | 0.5880 | 0.5940 | 0.6000 | 0.5980 | 0.5970 |
| | 1.0680 | 0.7820 | 0.6390 | 0.5980 | 0.5940 | 0.5900 | 0.5920 | 0.5930 | 0.5950 | 0.5960 |
| | 1.0220 | 0.7400 | 0.6040 | 0.5820 | 0.5840 | 0.5820 | 0.5940 | 0.5960 | 0.5970 | 0.5830 |
| 360 | 1.1170 | 0.8310 | 0.6580 | 0.6090 | 0.6000 | 0.5930 | 0.5980 | 0.6000 | 0.5950 | 0.5970 |
| Average | 1.076 | 0.795 | 0.638 | 0.587 | 0.579 | 0.580 | 0.586 | 0.591 | 0.593 | 0.593 |
| SD 0.043 | 0.032 | 0.018 | 0.009 | 0.007 | 0.007 | 0.008 | 0.009 | 0.008 | 0.008 | |
| Maximum | 1.187 | 0.887 | 0.691 | 0.609 | 0.600 | 0.598 | 0.606 | 0.619 | 0.618 | 0.616 |
| Minimum | 0.975 | 0.732 | 0.600 | 0.560 | 0.554 | 0.552 | 0.553 | 0.559 | 0.560 | 0.564 |



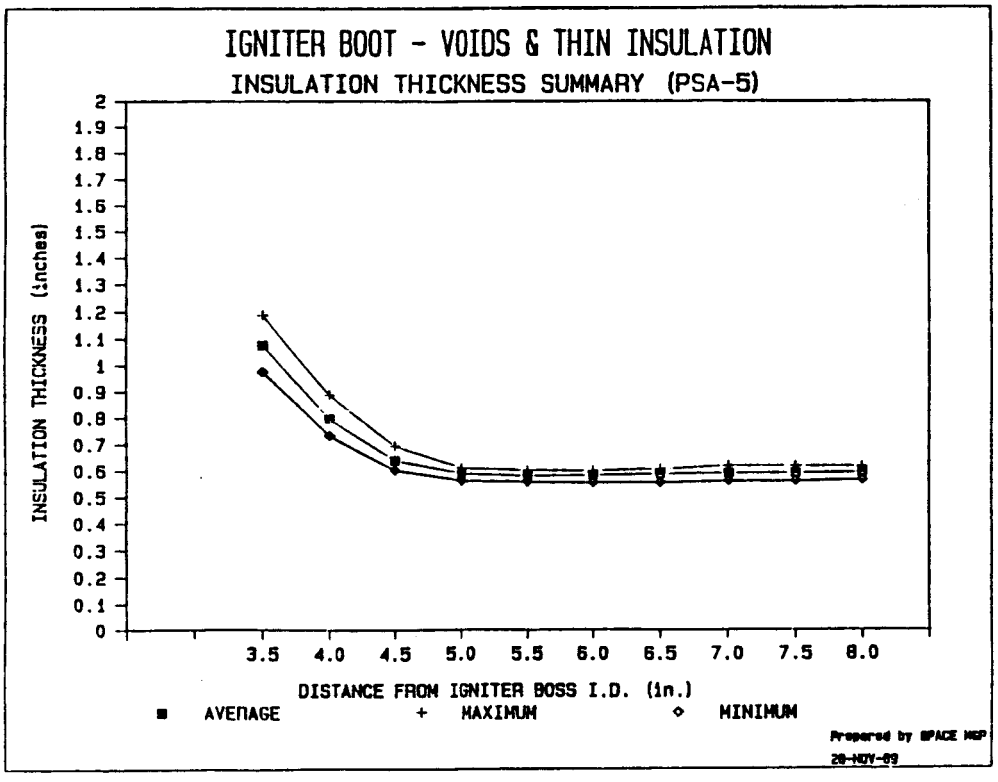




Figure 8. Thickness and Circumferential Profile Graphs

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## APPLICABLE DOCUMENTS

| Document No. | Title |
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| CTP-0161 | Test Plan, RSRM Forward Dome Inhibitor Void/Thin Insulation Process Change Validation |
| CDW1-3600 | Prime Equipment Contract End Item Detail Specification |
| TWR-16278 | SRM Internal Insulation Design Database |
| TWR-16742 | RSRM Internal Insulation Design Rationale Definition |

| Drawing No. | Title |
|---|---|
| 1U76666 | Case Assembly, Forward Segment, Insulated |
| 7U77105 | Forward Dome Process Verification Test Article |
| 5U77105 | Forward Igniter Boot Process Chamber Layup |

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